The Influence of Nutrition on Foliage Growth and Tip Necrosis on Container-grown *Chamaecyparis lawsoniana* 'Ellwood's Gold'

Michael B. Thomas, Brent A. J. Richards, and Mervyn I. Spurway
Department of Plant Science, Lincoln University, Canterbury

Container-grown *Chamaecyparis lawsoniana* 'Ellwood's Gold' were evaluated for the influence of N, P, and liming levels on tip necrosis and growth responses using a three factor central composite design. Plant height, spread, and foliar dry matter production increased strongly with added N and P, particularly when both were added at high levels. Liming depressed growth while tip necrosis primarily occurred at low or nil N, especially when combined with nil P. Rates equivalent per month to 80 to 90 g N m-3 and 40 g P m-3, along with nil or low lime (pH 4.5) were recommended to maximise growth rates and minimise tip necrosis.

INTRODUCTION

The *Chamaecyparis lawsoniana* 'Ellwood's Gold' is a commonly grown ornamental golden conifer. A nutritional trial was set up to investigate the problem of tip burn or necrosis which had been noted on a South Island nursery.

Large growth responses to added N, with a range of small conifers grown in outdoor beds, were reported by Benzian (1965). In a trial carried out with a range of soilless media using *Chamaecyparis lawsoniana* 'Ellwoodii', the largest plants were observed at the highest level of fertilisation equivalent to 675 g N/m^3 of 5-6 month slow-release fertiliser (Anon, 1993). However, Istas et al. (1986) reported little affect on growth when comparing several fertilisers at 3 or 4 kg m^{-3} on *C. lawsoniana* 'Columnaris'. A similar trial was used by Anon (1990) to look at the response of the latter species to different fertilisers, but growth was relatively poor in response to various mixtures of slow-release fertilisers.

Hawkins (1992) reported that rooted cuttings of the yellow cypress (*C. nootkatensis*) exposed to very low levels of nutrients were less tolerant of low N than low P or K, although plants survived very low additions if given balanced nutrient levels. Nutrients provided in excess resulted in luxury consumption and eventually resulted in plant death. However, there were clonal response differences.

Field work conducted on *C. lawsoniana* 'Alumii' resulted in a recommendation of 1.7% to 1.9% foliar N content for good plant growth and quality (van der Boon, 1986). Winter injury, as evidenced by browning, was more serious in the plants with higher N contents. Container research conducted by Thomas (1984) resulted in the conclusion that the ×*Cupressocyparis leylandii* (Leyland cypress) requires medium to high N fertiliser levels but prefers an acid mix with a pH of about 4. High liming coupled with low N rates was particularly unfavourable for growth. This contrasts with other work (Anon, 1990) when researchers found that this species preferred a pH of 6.5, while superior results occurred at pH 5.5 for *Juniperus* ×*media* and *Taxus baccata*, and pH 4.5 for *Thuja plicata*.

An experiment was carried out to evaluate the influence of N, P, and lime on the foliage growth of *C. lawsoniana* 'Ellwood's Gold' so as to provide a fertiliser recommendation for future production.

METHODS AND MATERIALS

The experiment was a three factor response surface Box-Hunter design by Cockram and Cox (1957) of the composite second order type with incomplete blocks. The three factors were N, P and lime, with 20 treatments arranged in four blocks, i.e., there were four replicates per treatment.

A medium of 4 medium-grade composted *Pinus radiata* bark : 1 washed crusher dust sand (< 5 mm) (v/v) was used. Rates of N, P, and lime were supplied by using Osmocote 23N-0P-0K, Osmocote 0N-18P-0K, and dolomite lime ($MgCO_3/CaCO_3$), respectively. The N and P fertilisers were applied in two split applications, at the start of the trial and after 8 months. All treatments included a basal application of Osmocote 0N-0P-37K (supplying 37% K) at 893 g m^{-3} and Micromax (trace elements) at 300 g m^{-3}. The formulations of Osmocote were all of 5 to 6 months duration.

The media and fertilisers were well mixed and transferred to PB 6½ (3.9 litre) planter bags. Even grade rooted cuttings (i.e., 7-cm tubes) of *C. lawsoniana* 'Ellwood's Gold' were bagged up with one plant per bag.

The trial was set up in June 1992 and plants were arranged in blocks outside in a sheltered area. Plants were watered by overhead sprinklers.

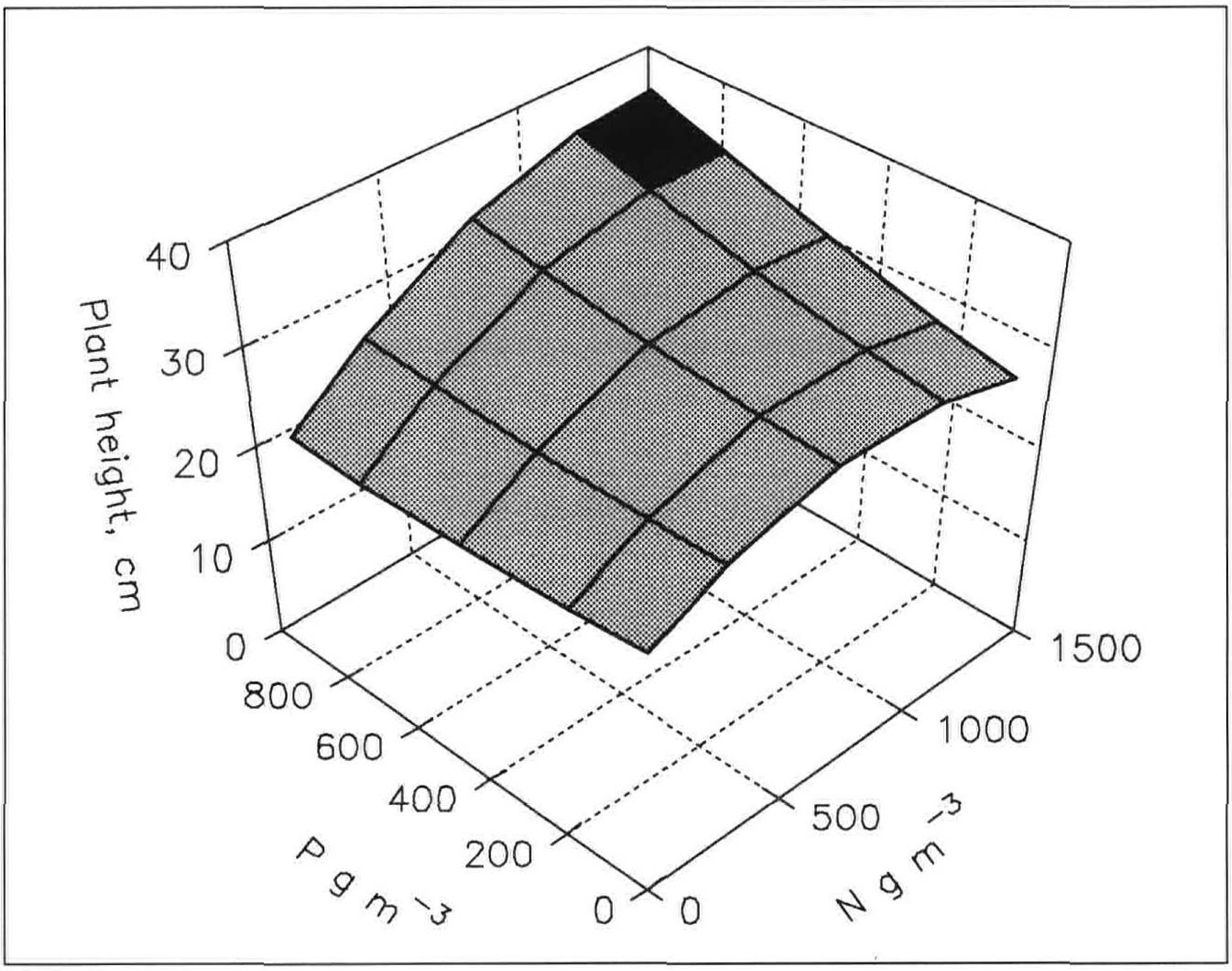

Figure 1. Influence of P and N on height.

Assessments were carried out during the running of the trial as well as foliar and media analyses which were done at 7 months. Visual ratings of foliage necrosis were carried out using a grading system to assess the amount of tip burn or necrosis (1 = severe tip necrosis to 5 = no tip necrosis). Slight necrosis was judged to be evidenced by white or severely chlorotic tips deemed not to be natural colouring for this cultivar. Media analyses indicated levels (mg/litre for all) of 3, 1, 18, 4, 10, 6, and 10 for NO_3-N, NH_4-N, P, K, Ca, Mg, and Na, respectively for the treatment with the middle rate of N, P, and lime. The next lower rate of N and P recorded levels of 1 and 16 mg $litre^{-1}$ of NO_3-N and P respectively, while the second to highest rate of these two nutrients showed levels of 21 and 55 mg $litre^{-1}$, respectively. The NH_4-N levels were found to be at 1 mg $litre^{-1}$ for all three treatments. Final measurements and harvest were carried out in Sept. 1993 after the trial had been running for 14½ months. Tops were dried and weighed.

RESULTS

Measurements taken at the completion of the trial showed that the height of the conifers was influenced by all the fertiliser and lime additions and this confirmed recordings taken earlier. On each occasion the tallest plants were those supplied with the highest rates of N and P (Fig. 1, earlier data not shown). The response to N was quite strongly dependant on high levels of added P. The additions of N and P were also important for the spread of the plants; this interaction is shown in Fig. 2 for final measurements. The shape of the surfaces that predict height and spread

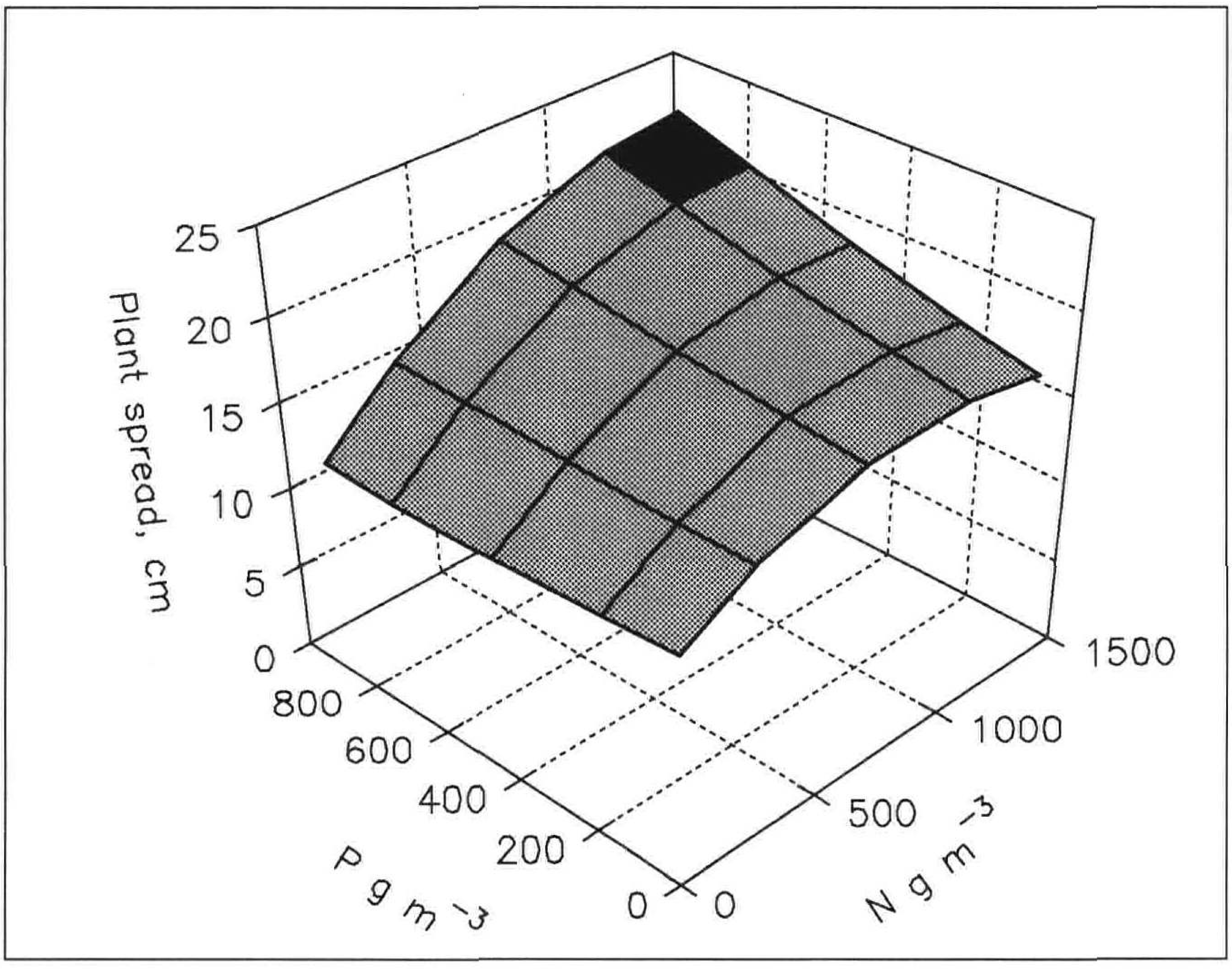

Figure 2. Influence of P and N on spread.

in response to N and P are similar. Fig. 3 shows the interactive effects of N and liming on plant spread. In this case lime had a negative effect, with the widest plants receiving the highest rate of N fertiliser but no added lime.

The foliage of the plants was rated for tip necrosis at 6 and 13 months after potting-up and just before final harvest. Early indications were that N deficiency was the most serious cause of tip burn although high rates of P, especially in the absence of lime, were also detrimental (data not shown). Plants rated just before harvest confirmed the earlier observations. Tip necrosis was most severe at nil N and P (Fig. 4). This was also predicted to be moderately severe at nil N and with increasing levels of P or when N and P were both at their highest levels. Necrosis at high levels of N and P did not confirm early observations when no tip necrosis occurred at these levels (data not shown). Therefore, the most consistent factor inducing tip burn was N deficiency.

The most significant aspect of the foliar nutrient levels, measured at about the half-way point in the experiment, was that the N content was 1.3% at the second lowest rate of N fertilisation but increased to nearly double this concentration when the plants were supplied at the second highest rate of N (Table 1).

Foliar dry weights confirmed the height and spread measurements. Dry matter production of foliage was predicted to be strongest at the highest levels of N and P (Fig. 5). These predicted figures relate well to the observed or actual weights, since the six plants with the greatest dry matter production all had the combination of high levels of N and P fertilisation. The foliar weight of plants when given high N

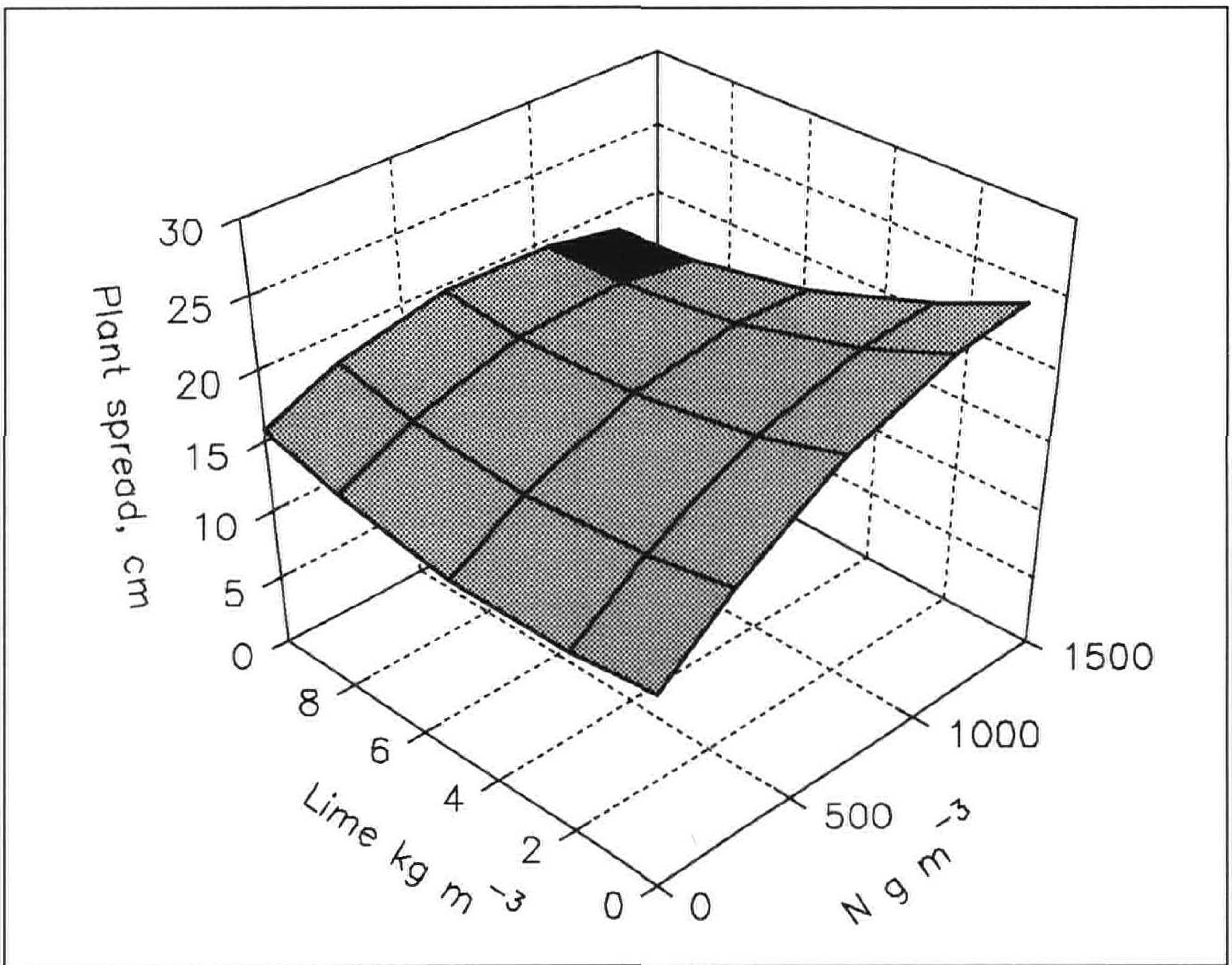

Figure 3. Influence of lime and N on spread.

with low P were predicted to more than double if the highest P rate was also applied. However, increasing lime levels reduced foliar dry weights except at low N (Fig. 6). Liming also depressed predicted foliar dry weights at nil or low P, but greatest predicted dry matter production was when both P and lime were at highest levels together (Fig. 7).

Table 1. Foliar nutrient levels.

Treatment Nutrients (g m^{-3})			Foliar nutrients %						μg g^{-1}				
N	P	Lime	N	P	K	S	Ca	Mg	Fe	Mn	Zn	Cu	B
267	178	2030	1.3	.41	1.7	.14	.97	.26	131	192	90	6	22
659	439	5000	2.1	.47	1.6	.17	.83	.24	113	108	61	7	18
1052	696	7970	2.3	.46	1.3	.11	.98	.23	213	87	74	11	17

DISCUSSION

High N levels were shown to be particularly important in ensuring good growth and minimal tip burn. Nitrogen levels have been shown to be a key aspect in the

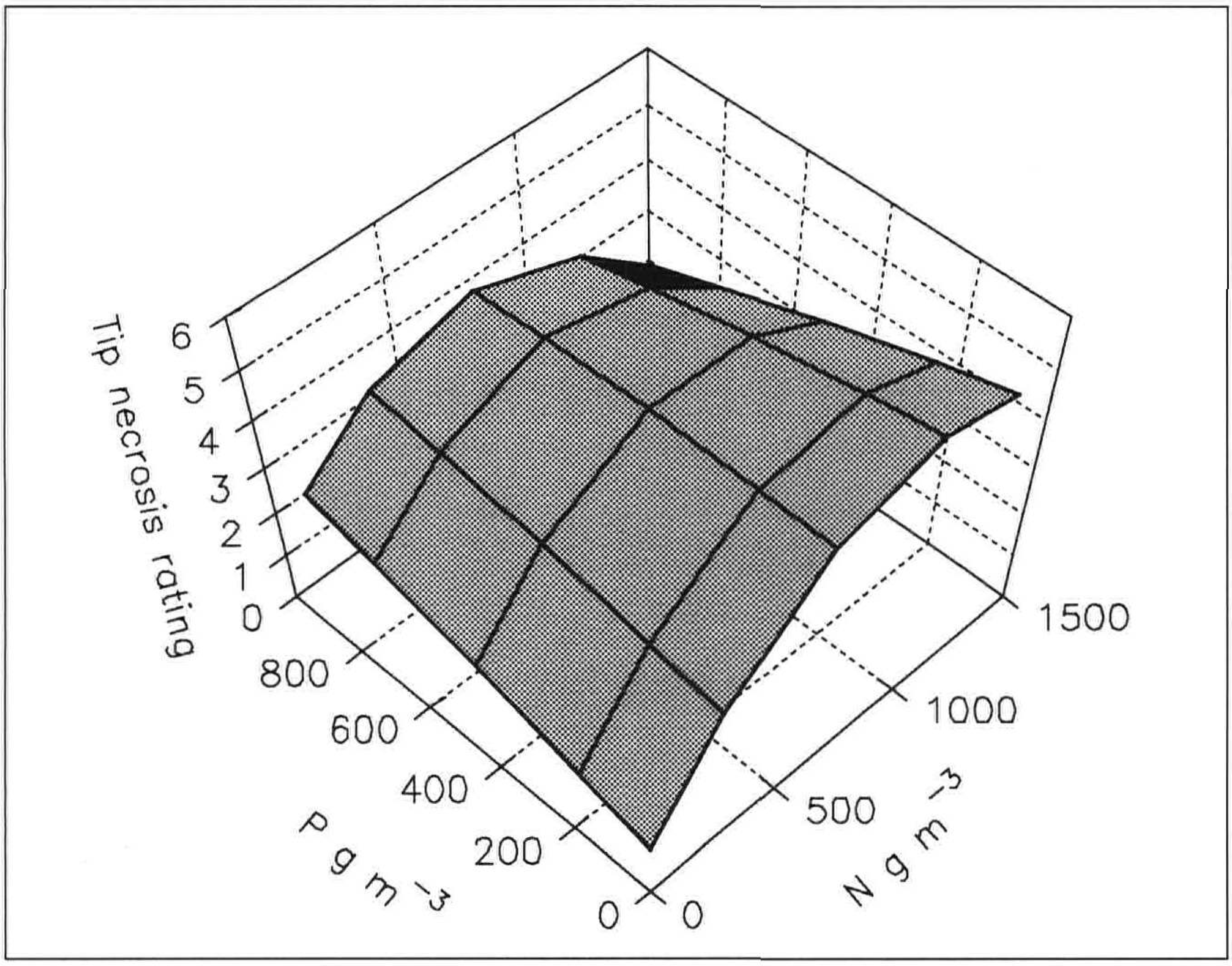

Figure 4. Influence of P and N on tip necrosis.

nutrition of container-grown plants in soilless media (Thomas and Baird, 1983) and can be expected to give large growth responses in small conifers when grown in forestry seedbeds with adequate watering (Benzian, 1965). Another feature of the results was the strong value of adding high P along with high N rates. It has been observed that pot plant crops like *Ficus macrophylla* (Thomas and Teoh, 1983) and herbaceous plants respond strongly to added P, whereas a range of trees and shrubs were found to be relatively unresponsive (Thomas, 1981).

Liming was found to generally reduce foliage growth even at high N levels, where this fertiliser addition would have been expected to have depressed the pH. This indicates a preference for acid conditions since N fertilisation would be expected to lower the pH of the medium. This was in full agreement with similar work on Leyland Cypress (×*Cupressocyparis leylandii*) which grew strongly in response to slow release N at a rate equivalent to about 100 g N/m^3, yet plants had their greatest spread and height at nil added lime (Thomas, 1984). Benzian (1965) had noted, from the examination of soil samples from over 100 nurseries, that conifer seedlings grew poorly when soils were neutral or only slightly acid. A further aspect about liming could be the reduction of available P due to the formation of insoluble calcium phosphates, and would account for poor foliage growth when P was at nil or low levels, coupled with high rates of liming (Fig. 7). High lime rates were, however, not predicted to be a problem if high rates of P are used along with high liming.

Two other potential causes of tip burn are frost damage and cypress canker (*Monochaetia unicornis*). No assessment was made on the effect of these factors,

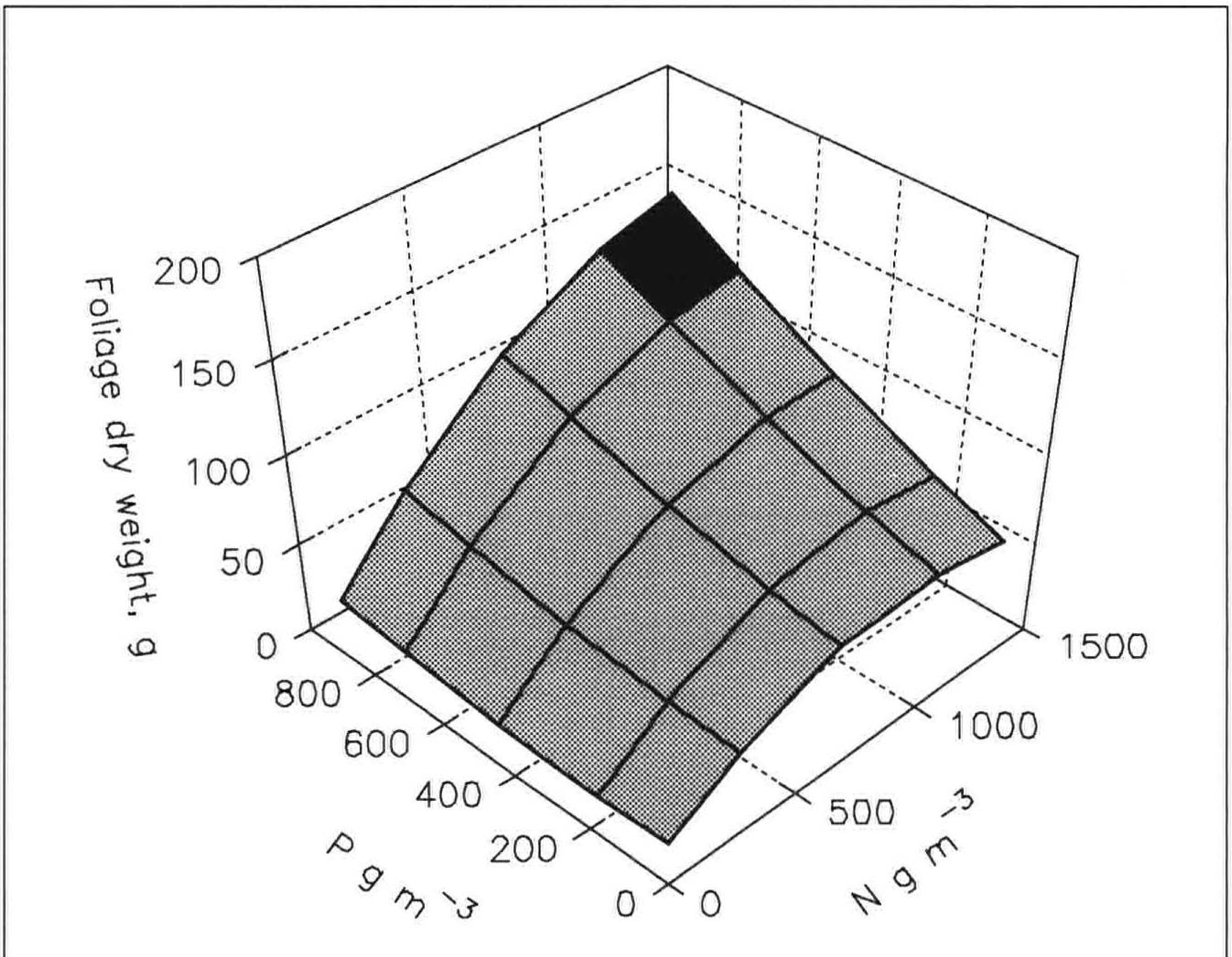

Figure 5. Influence of P and N on foliage dry weight.

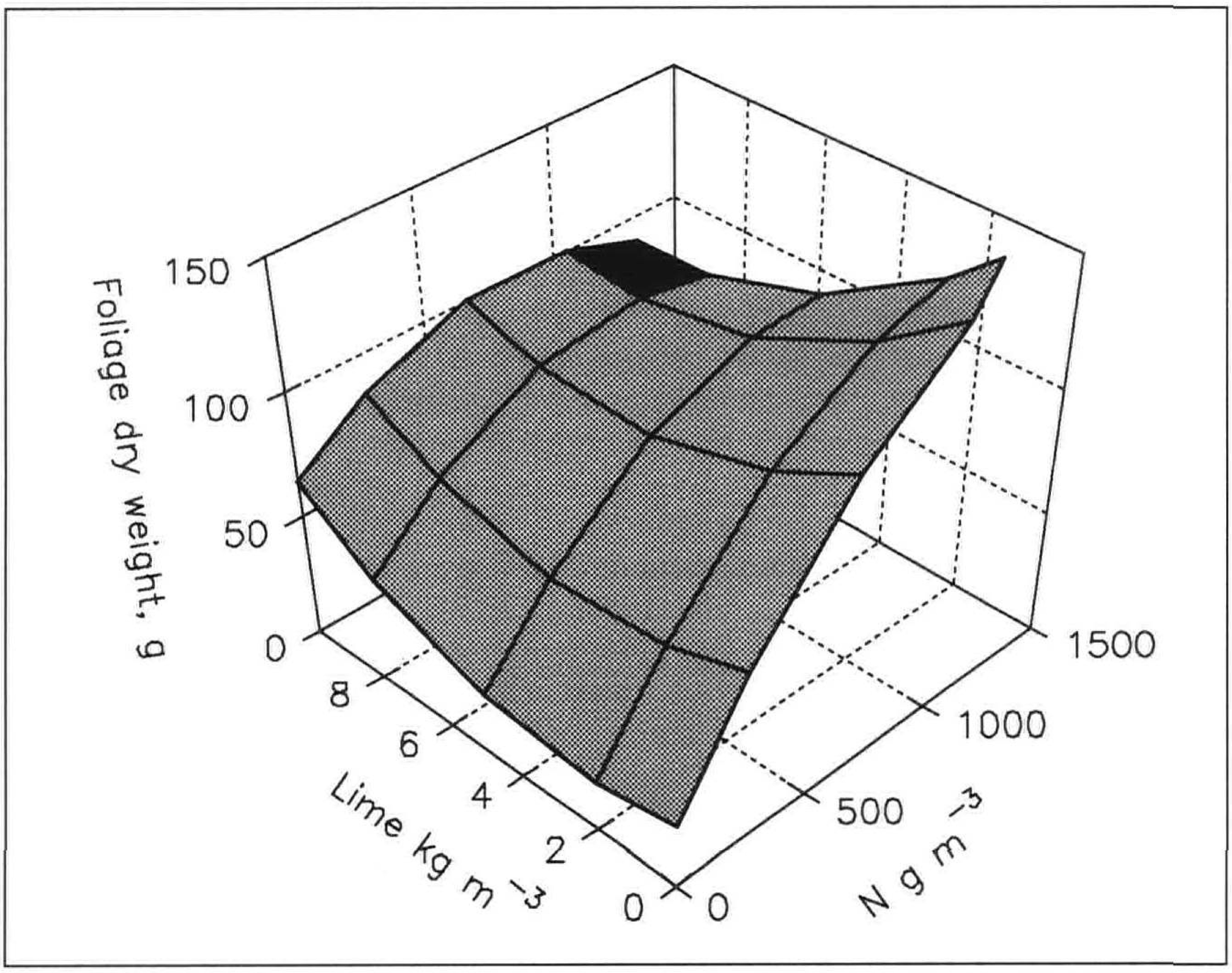

Figure 6. Influence of lime and N on foliage dry weight.

however, van der Boon (1986) noted that frost damage occurred at high N rates while the results reported here showed least tip burn at this level.

CONCLUSION

In conclusion, it is suggested that high N (1200 to 1300 g N/m^3) coupled with medium levels of P (600 g P/m^3), and little or nil added lime are recommended. Monthly nutrient release rates based on the equivalent of about 80-90 g N m^{-3} and 40 g P/m^3 for slow-release fertilisers and a pH for the medium of about 4.5 are suggested. It is proposed that these additions should help to promote growth and quality with minimal tip necrosis in this species.

Acknowledgements. We thank Wallis's Nurseries Ltd., Mosgiel for the supply of plants and funding of media and plant tissue analyses. We also thank Gilbert Wells for help with computing work and Grace Sierra for the supply of Osmocote single nutrient formulations.

LITERATURE CITED

Anon. 1990. Trials with container culture. Verbondsnieuws voor de Belgische Sierteelt 34:279-282. From : Hort. Abstracts 62:2318. 1992.

Anon. 1993. Fertilization with Osmocote Plus controlled-release fertilizer of container grown nursery stock plants in alternative potting soil mixes. Grace Sierra Information Bulletin NR16 (Jan):3-5.

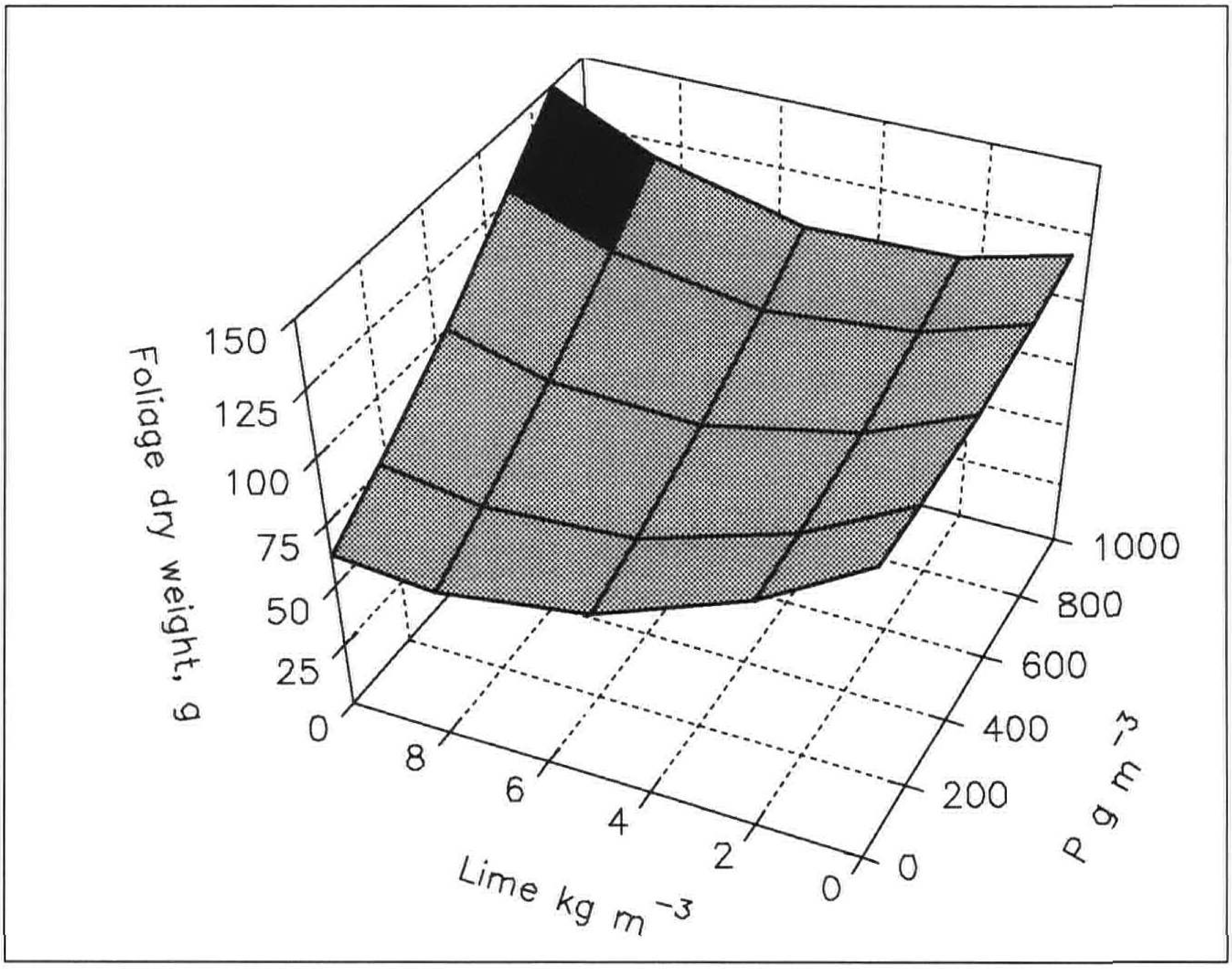

Figure 7. Influence of lime and P on foliage dry weight.

Benzian, B. 1965. Experiments on nutrition problems in forest nurseries. Forestry Commission Bulletin 37. H. M. Stationary Office London.

Cochran, W.G. and **G.M. Cox.** 1957. Experimental designs. New York, Wiley.

Hawkins, B.J. 1992. The response of *Chamaecyparis nootkatensis* stecklings to seven nutrient regimes. Can. J. For. Res. 22:(5)647-653.

Istas, W. and **R. Moermans.** 1986. Growth trials with slow-release fertilizers for conifers in containers. Verbondsnieuws-voor-de-Belgische-Sierteelt 30:(19)1042-1043. From: Hort. Abstracts 58:463. 1988.

Thomas, M. B. 1981. Nutrition of five species of container-grown *Acacia, Boronia, Choisya* and *Eucalyptus*. Scientia Horticulturae. 14:55-68.

Thomas, M. B. 1984. Research Report: Container mix needs for three woody plants. Commercial Horticulture (Feb):21-22.

Thomas, M. B. and **A. Baird.** 1983. A review of research into the nutrition of container-grown shrubs at Lincoln College. Roy. NZ Instit. Hort. Ann. J. 10:53-57.

Thomas, M. B. and **S.L. Teoh.** 1983. Culture of container-grown *Ficus macrophylla*. I. Influence of nutrition on foliage growth. Roy. NZ Instit. Hort. Ann. J. 11:67-76.

van der Boon, J. 1986. An N, K, and Mg fertilization experiment with Chamaecyparis. Rapport, Instituut-voor-Bodemvruchtbaarheid. From: Hort. Abstracts 59:1373. 1989.